July 2021 Volume 7, No. 1

LSU Medical/Health Physics Newsletter

LSU Department of Physics & Astronomy

MARY BIRD PERKINS CANCER CENTER™

Message from the Program Director

Dear Alumni, Students, Colleagues, and Friends:

We hope that this newsletter finds you in good health and fine spirits. To those who lost loved ones during the pandemic, we offer our sincere condolences. This past year or so has been a unique period in our lives, communities, and our history. In conversation, we seem to refer to time in three eras, namely, pre-pandemic, pandemic, and post-pandemic. This newsletter covers a one-year period squarely within the pandemic. It is curious that, during the pandemic, so many unexpected things happened and so many expected things didn't. We will cover highlights of these in this issue of our newsletter.

It is hard to believe how dramatically the outlook has improved, both in general and for the Medical Physics and Health Physics Program. In spring of last year, things looked quite uncertain. The vaccine was distant goal, there were shortages of toilet paper (of all things), and we had an indefinite order to shelter in place (at home). As of this writing, vaccines are widely available in many developed countries, shortages seem to be resolving, and many have resumed working at their pre-pandemic workplace. At LSU, we are tentatively planning to be fully back to in-person and on-site beginning with the fall semester.

Last year we were saddened by the death of Dr. Charles M. Smith, a Louisiana physician and longtime supporter of the LSU/MBPCC Medical Physics and Health Physics Program. His support continues to have a profound positive impact on program. He leaves a legacy of generosity, forward thinking, and of love for LSU and Louisiana.

As the Program Director, the biggest surprise over the past year was how well everything has turned out. Progress continued with little interruption, *e.g.*, students graduated on schedule, major projects were completed on time, and exciting new projects were begun. In light of the challenges of working remotely and in relative isolation, this outcome is remarkable. It would be difficult to overemphasize how well our students, faculty, and staff worked together to overcome the challenges we faced. The teamwork and sense of community were inspiring. We hope you enjoy reading about many of the achievements and successes of our students and faculty over the past year. Sincerely,

Wayne Newhauser, PhD

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Medical & Health Physics Alumni Newsletter is published by the LSU Medical & Health Physics Graduate Program

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Feedback from alumni is always welcomed by the Program. Please send your suggestions or comments to:
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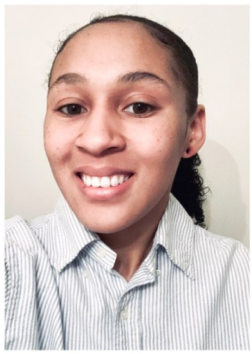
2020 Fall new students holding masks in front of oak trees

Meet the class of 2020

Afshari, Nousha
BS/2016
California State University, Fullerton
PhD tract (MP) /2020-present



Carr, Sydney
BS/2020
Houston Baptist University
MS tract (MP) 2020-Present

Cole, Maxwell
BS/2020/
Louisiana State University
PhD tract (MP) /2020-present

Chuang, Kai-Cheng
MS/2020
Duke University
PhD tract (MP) /2020-present/

Crist, James
BS/2019
Brigham Young University-Idaho
MS tract (MP) 2020-Present

Medlock, Lacey
MS/2019
Western Michigan University
MS tract (MP) 2020-Present

McGuffey, Andrew
MS/2020
Louisiana State University
PhD tract (MP) /2020-present

Smith, Bryce
BS/2020
Louisiana State University

From left to right: 2020 new students Bryce Smith, Sydney Carr, Nousha Afshari, Lacey Medlock, Maxwell Cole, Kai-Cheng Chuang, and James Crist

Sengupta, Bishwambhar
Ph.D/2019
Clemson University, SC
Certificate Program/2020-present

Trainee Milestones - Certifications

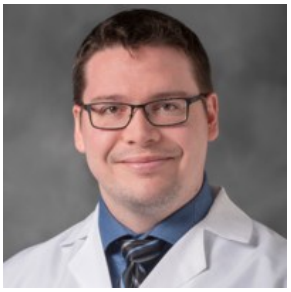
Congratulations to all students who have made progress in achieving certification. The following students have chosen to disclose their status.

Ana L. Dieguez
MS student (medical physics)
Passed Part I of the ABR Exam

Ivan Hidrovo-Giler
MS student (medical physics)
Passed Part I of the ABR Exam

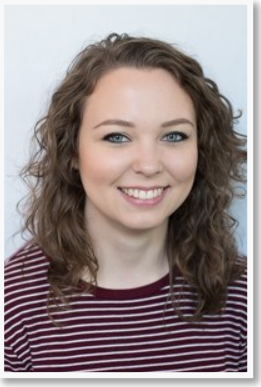
Jared Taylor
PhD student (medical physics)
Passed Part I of the ABR Exam

Michael G. Stock
MS student (medical physics)
Passed Part I of the ABR Exam



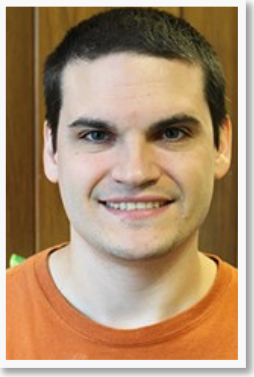
Joseph R. Steiner
PhD Alumni (medical physics)
Passed Part II of the ABR Exam

2020 Program Graduates



Audrey Copeland, MS

Advisor: Jonas Fontenot, Ph.D.
Therapy Residency
Thomas Jefferson University Hospital in Philadelphia, PA



Andrew Hastings, MS

Advisor: Wei-Hsung Wang, Ph.D.
Health Physicist
Sandia National Laboratories

Troy Jacobs, MS

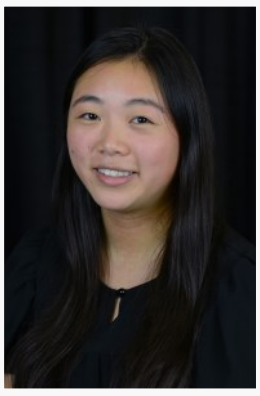
Advisor: Kenneth "Kip" Matthews, Ph.D.
Therapy Residency
Willis-Knighton Cancer Center

Krystal Kirby, Ph.D.

Advisor: Owen Carmichael, Ph.D.
Imaging Residency
Mayo Clinic in Rochester, MN

Andrew McGuffey, MS

Advisor: Justin Sick, Ph.D.
PhD student
Continue Ph.D. study at LSU



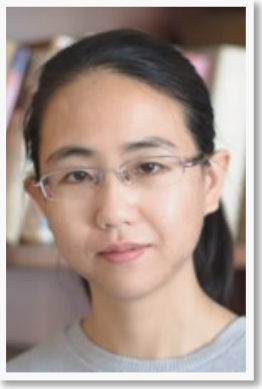
Stephanie Wang, MS

Advisor: Robert Carver, Ph.D.
Therapy Residency
Henry Ford Health System, Detroit, MI

2020 Program Graduates

Phillip Wall, Ph.D.

Advisor: Jonas Fontenot, Ph.D.
Therapy Residency
University of California at San Francisco



Jinzhu Xu, Ph.D.

Advisor: Joyoni Dey, Ph.D.
Therapy Residency
University of Maryland, MD

Yibo Xie, Ph.D.

Advisor: Rui Zhang, Ph.D.
Therapy Residency
Duke Cancer Center, Durham, NC

Xiaodong Zhao, Ph.D.

Advisor: Rui Zhang, Ph.D.
Therapy Residency
University of Alabama at Birmingham

James Kavanaugh, PhD

Advisor: Jonas Fontenot, Ph.D.
Assistant Professor in Radiation Oncology
Washington University School of Medicine in St. Louis

LSU CLASS OF AUGUST 2020 GRAD SPOTLIGHTS

Aug 10, 2020 12:02:17 PM / by LSU Alumni Association Staff

Degrees: PhD medical physics

University of Memphis, BS Physics and Mathematical Sciences 2014

Hometown: Bartlett, Tennessee

Career Plans: Imaging physics residency at Mayo Clinic in Rochester, MN

PhD Dissertation: Applications of Advanced Structural and Functional MRI Methods

During her time at LSU, Krystal continued to amaze the scientific community with her knowledge shown through participation in multiple innovative studies with her Faculty Mentor Owen Carmichael, Pennington Biomedical Research Center. In 2017, her focus was on combating obesity and improving cancer treatment. She aimed to develop a new technique that could provide the soft tissue contrast that obesity scientists need to better understand brown fat, a concept that occurred to Kirby while taking a graduate course on mathematical physics at LSU. Read more about the study here. From this work, she was awarded an Economic Development Assistantship by the LSU Graduate School. In 2018, she played a key part in a study focused on bilateral transfer of learning. The study took a first step toward understanding how and why some older adults are better than others at learning new motor skills. Read more about the study here.

Krystal Kirby

Advisor: Owen Carmichael, Ph.D.

Degrees: PhD in medical physics

University of Memphis, BS Physics and Mathematical Sciences 2014

Hometown: Bartlett, Tennessee

Career Plans: Imaging physics residency at Mayo Clinic in Rochester, MN

A Message from the 2020-21 Student-Faculty Liaison

Ana L. Dieguez, M.S Student Student's Liaison

At the beginning of the fall semester, Louisiana was experiencing a high surge of daily COVID-19 cases, all while us students were getting ready for a new academic year. Needless to say, we started this semester with hesitant inner questionings of: "how will classes look like in the middle of this pandemic? Will the hybrid learning model work?" Now, thanks to the great effort of the faculty and students alike, I can proudly say that the Fall 2020 semester was a success in spite of the circumstances. With a new incoming class and students preparing for what comes next to graduate school, very many academic goals were achieved.

While there was some great advancement in academics, the student safety regulations caused daily student interaction to be inherently lost. In a time where social distancing and isolation were necessary, this interaction was more important than ever. Normally, valuable discussions about research within students were held informally in day-to-day conversations and while these could not happen, with the help of other fellow classmates the student research group was resuscitated. In this semester alone four groups met biweekly with great attendance numbers from students in all phases of their research journey. In addition, the Mary Bird Perkins-LSU Journal Club spotlighted the research from the senior students once a month in the form of presentations; also holding the very first Medphys SLAM! Style competition in September. Both activities soared with great attendance from students and faculty alike, bringing great benefit not only for the continuity of the activities but also provided invaluable feedback for the students' own research work and communication skills.

After a year without precedent and with most of our daily routines affected severely; the response from this program's students was that of succeeding in times of adversity. It has only been one semester out of the academic year so far, but with all the groundbreaking work put in by the students there is no doubt that this academic year will end up being fruitful both academically and professionally for us. For this success we also want to thank all the faculty members, whose guidance and effort has been of great assistance in this new normality. May the Spring and Summer Semester bring many more achievements to celebrate as a program.

STUDENT UPDATE

Selected Honors and Awards

- Ana Dieguez Awarded Hogstrom Superior Graduate Student Scholarship. Read more https://bit.ly/3ju41NJ

- PhD student Michelle Lis received the Coates Travel Research Award. Michelle is currently in the final stages of completing her PhD in medical physics research. She has over 6 years of experience in radiation oncology therapies, building strategic partnerships with international, cross-functional teams, science outreach, scientific communication, didactic teaching and mentorship.

- PhD graduate Phillip Wall was announced as the 2020 winner of the Coates Outstanding Dissertation Award.

- 2020 PhD graduate Krystal Kirby received the prestigious Morin Fellowship from the American College of Radiology (ACR). It's a huge honor in the diagnostic physics world (only two people in the country are awarded the fellowship).

- MS alumnus, Olivier Blasi, was elected as a member of the AAPM Board of Directors, as the Board Representative from the Rocky Mountain Chapter.

- The Southwest Regional Chapter of the American Association of Physicists in Medicine has announced LSU Associate Professor Kenneth “Kip” Matthews as the 2020 recipient of the prestigious Robert J. Shalek Award. Read more https://bit.ly/38uHHx2

Louisiana Space Grant
Research Award

LSU Department of Physics & Astronomy graduate student Megan Chesal and undergraduate Haley Pellegrin have been granted Louisiana Space Grant student research awards.

Under the direction of Assistant Professor Jeffery Chancellor, both students will receive a monetary stipend for research work conducted in Chancellor's lab. In addition to hands-on technical experience, these students will be offered other professional development opportunities, like presenting their work at professional meetings while also working towards their LSU degree.

The fundamental premise underlying Louisiana Space Grant Consortium (LaSPACE) programming is involvement in research at all levels (undergraduate, graduate, and faculty) that aligns with NASA research priorities and mission goals, and then leveraging that infrastructure to increase NASA-relevant science literacy around the state. Building transdisciplinary teams that perform research and provide educational opportunities is the key to developing the 21st century workforce desired by both NASA and the State of Louisiana.

An LSU 2018 BS physics alumna, Megan Chesal is currently a third-year medical physics graduate student. Her research with Dr. Chancellor involves a physiological scalable analog that can simulate the non-homogenous space radiation environment in a laboratory setting. The 2020-2021 LaSPACE Graduate Student Research Assistance (GSRA) award will augment Chesal's student stipend, help to defray dissertation related research expenses, and promote student research presentations at national meetings.

"This research is highly relevant to the NASA Human Exploration and Operations Mission Directorate (HEOMD)," said Chancellor. "Megan has been working in my research laboratory and she intends to pursue a career in aeronautics."

Receiving a 2020-2021 LaSPACE Undergraduate Research Assistantship (LURA) award, Haley Pellegrin is a senior undergraduate working in Dr. Chancellor's SpaRTAN Physics laboratory, conducting research on the development of an AI based deep generative design framework and topology optimization for spacecraft radiation shielding.

Award Recipient

Megan Chesal

Her research with Jeffery Chancellor, Ph.D., involves a physiological scalable analog that can simulate the non-homogenous space radiation environment in a laboratory setting. The 2020-2021 LaSPACE Graduate Student Research Assistance (GSRA) award will augment Chesal's student stipend, help to defray dissertation related research expenses, and promote student research presentations at national meetings.

CONGRATULATIONS!

"This lab's work is highly relevant to NASA HEOMD," said Chancellor. "The overall goals of the lab will help develop Haley's technical, scientific, and professional development skills. Although Haley is relatively new to space science applications of medical physics, this project could impact her career path."

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colleenf@lsu.edu

1st Award

Megan Chesal

A Physiological Scalable Analog for Simulating the Non-homogenous Space Radiation Environment in a laboratory setting

LSU-MBPCC JOURNAL CLUB

JOURNAL CLUB SLAM 5X5

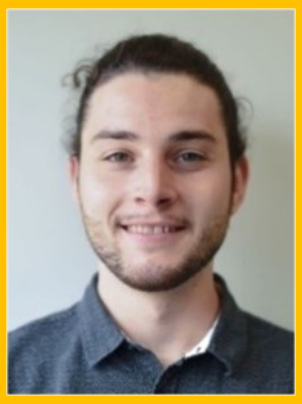
THE PRESENTATION CHALLENGE:

5 SLIDES IN 5 MINUTES

EFFECTIVELY COMMUNICATE YOUR RESEARCH TO NON-SPECIALISTS.
ALL UNDERGRADS, GRAD STUDENTS, POSTDOCS, AND RESIDENTS ARE INVITED TO SUBMIT AN ABSTRACT.
TOP 6 ABSTRACTS WILL BE SELECTED TO PRESENT.
ABSTRACT SUBMISSION DEADLINE: AUGUST 21ST, 2020

2nd Award

Michael Stock



Validation of a gating system featuring the Elekta Response gating interface paired with an in-house patient position monitoring system for automated deep inspiration breath-hold delivery

PRESENTERS

Megan Chesal

Ana Dieguez

Michael Stock

Charles Zimmerman

Thanks to our judges' panel for volunteering their time for this event and for making the difficult decision of 1st and 2nd place awards: Dr. Suchit Patel, Eddie Singleton, and Ryan McGriff

And a very special thanks to our Graduate Student Liaison – Ana Dieguez for her leadership and large role in making this event a reality!

David Solis, PhD

Selected New Grants

1. Dr. Jeffery Chancellor received 1.8 million from NASA's Human Research Program. NASA's Human Research Program works to address the practical problems of spaceflight that impact astronaut health, and its research may provide knowledge and technologies that could improve human health and performance during space exploration and aid the development of potential countermeasures for problems experienced during space travel.
2. Dr. Joyoni Dey received an NIH NIBIB Trail-blazer Award 1R21EB029026-01A1 (PI: Dey, J). "Breast Cancer Detection and Imaging using Analyzer-less X-ray Interferometry". This is a three-year project with funding for a Ph.D. and an MSc student each year. The funding is a total of $524,584.
3. Dr. Jeffery Chancellor received $69,945 from the Translational Research Institute for Space Health (TRISH) as Co- Investigator (Co-I) for the grant, Characterization of Radiation Environment During SpaceX Inspiration 4 Mission. Here we are developing radiation hardware that will interface with an iOS platform and measurement internal particle spectrum.
4. Dr. Jeffery Chancellor received $75,000 from the LSU College of Science and Office of Research & Development Funds to facilitate the Tiger Eye 1 Mission To Lunar Surface Principal Investigator (PI)
5. Dr. Jeffery Chancellor received $249,000 from NASA Space Biology for the grant, Develop a novel single-cell biodosimetry for brain genomic instability and neurodegeneration to predict clinical health outcomes in human spaceflight crews.
6. Dr. Jeffery Chancellor received 68,612 from for the grant Using human stem-cell derived vascular, neural and cardiac 3D tissues to determine countermeasures for radiation.
7. $16,000 LaSPACE Graduate Research Fellowship was awarded to Dr. Jeffery Chancellor's student, Megan Chesal, for development of a physiological scalable analog that can simulate the non-homogenous space radiation environment in a laboratory setting.
8. $12,000 LaSPACE Undergraduate Research Fellowship was awarded to Dr. Jeffery Chancellor's student, Haley Pellegrin, for the grant Development of an AI based deep generative design framework and topology optimization for spacecraft radiation shielding.
9. Dr. Jeffery Chancellor's received 2,112,000 CPUh (equivalent to ~$3,168,000) from the Texas Advanced Computing Center (TACC) Allocation for the grant Emulation of the Heavy-Charged Particle Spectra Found in Microgravity. received $75,000 from the LSU College of Science and Office of Research & Development Funds to facilitate the Tiger Eye 1 Mission To Lunar Surface Principal Investigator (PI)

Featured Stories

Ana Dieguez

Ana Dieguez Awarded Hogstrom Superior Graduate Student Scholarship

Oct. 8, 2020 By Mimi LaValle

LSU's medical physics and health physics program has announced Ana Dieguez as the second recipient of the prestigious Kenneth R. Hogstrom Superior Graduate Student Scholarship.

Established in honor of Professor Emeritus Kenneth R. Hogstrom's outstanding research, scholarship, and mentorship of graduate students, the scholarship supports medical physics graduate students participating in clinical research on radiation oncology at Mary Bird Perkins Cancer Center.

"Ana caught my attention with her first communication with me as a prospective student; Ana presented herself as professional, competent, and clearly interested in medical physics," said Kenneth "Kip" Matthews, associate professor and deputy program director. "When Ana asked me to supervise her thesis, I was impressed with how she'd pulled together multiple topics to envision an interesting research project. I also was extremely pleased when Ana was awarded the Kenneth R. Hogstrom Superior Graduate Student Scholarship, which honors a colleague who has significantly impacted my own career."
Dieguez, a 2017 University del Valle de Guatemala alumna, describes the importance of this award as she advances her career.

"From the moment I joined LSU's Medical Physics Program, I felt encouraged by the faculty to find a research interest that would represent an innovative approach into a dilemma in our field. In Fall 2019, I reached out to Dr. Kip Matthews to discuss possible research topics for my master's thesis. Dr. Matthews had taught the Radiation Shielding class, MEDP7530, the prior semester and he presented areas where insufficient knowledge could potentially be limiting the quality of Shielding Calculations."

"When I talked to Dr. Matthews, we decided that VMAT Shielding Considerations was an area, with direct relevance to clinics similar to the Mary Bird Perkins Cancer Center. This project is an assessment of whether the VMAT delivery technique is adequately addressed by the NCRP Report 151 guidelines for design of a LINAC vault's structural shielding. Report 151 was published before VMAT became a common treatment technique. As VMAT becomes the primary treatment approach for many types of cancer, we must be certain that existing and new treatment vaults provide suitable shielding."

"The main question of my thesis is whether the calculation methods and supporting data of Report 151 are sufficient to provide a satisfactory design for a vault dedicated to VMAT. This project will either confirm that existing Report 151 methods and data result in adequate designs or produce supplemental information by which we can be confident that new shielding designs are both safe and cost-effective."

"This topic is important to facilities such as Mary Bird Perkins Cancer Center, where appropriate radiation protection of staff and the public is crucial; importantly to me, this line of research represents what first inspired me to join the medical physics field: how to make effective and safe use of therapeutic radiation, allowing us to save lives without compromising quality. This project was envisioned by me, representing a new research direction for us, so obtaining funding was crucial. The Kenneth R. Hogstrom Superior Graduate Student Scholarship is the essential component that allows me to pursue this project as my Master's thesis; I am grateful to Dr. Hogstrom and all those who supported the creation of this Scholarship."

Featured Stories

NASA Supports LSU Physicist's Work to Advance Human Space Exploration

Dr. Jeffery Chancellor

Oct. 27, 2020 By Mimi LaValle

LSU Assistant Professor Jeffery Chancellor's research looks to help answer questions about astronaut health and performance during future long-duration missions beyond low-Earth orbit.

A low Earth orbit (LEO) is, as the name suggests, an orbit that is relatively close to Earth's surface. It is normally at an altitude of less than 1000 km but could be as low as 160 km above Earth – which is low compared to other orbits, but still very far above Earth's surface. The orbit of the International Space Station, as well as the majority of satellites have been in low-Earth orbit.

With $1.8 million in new funding from NASA's Human Research Program, Chancellor now joins a group of scientists who are investigating biological, physiological, and behavioral adaptations to spaceflight. The 21 selected projects will contribute to NASA's long-term plans, which include crewed missions to the Moon and Mars.

Chancellor's proposal "Integration of in-silico and in-vivo models for determining preclinical indicators and/or integrated biomarkers of radiation-induced vascular dysfunction," is focused on ways to help protect astronaut's cardiovascular health.

"We look to develop and validate a novel ground-based model to more accurately predict short- and long-term degenerative tissue effects of the space radiation environment and its health risks to astronauts, with an initial focus on the cardiovascular system," Chancellor said. "For this purpose, we first propose the use of a novel radiation moderator block that we believe generates an organ radiation dose distribution that more closely replicates that encountered by humans in deep space vehicles."

Chancellor's Space Radiation Transport & Applied Nuclear (SPARTAN) physics laboratory will conduct most of the research at LSU.

"We will also be exposing our models to a simulated cosmic ray spectrum at the NASA Space Radiation Laboratory located at Brookhaven National Lab in Brookhaven, NY," Chancellor said.

NASA's Human Research Program works to address the practical problems of spaceflight that impact astronaut health, and its research may provide knowledge and technologies that could improve human health and performance during space exploration and aid the development of potential countermeasures for problems experienced during space travel. The organization's goal is to help astronauts complete their challenging missions successfully and preserve their long-term health.

NASA has selected 21 proposals from a total of 19 institutions in 12 states, and the projects will receive about $19.3 million over a one-to-five-year period. Science and technology experts from academia, government, and industry reviewed a total of 109 proposals received in response to NASA's 2019 Human Exploration Research Opportunities Appendices C and D.

The complete list of selected proposals, principal investigators, and organizations can be found at:

https://www.nasa.gov/feature/nasa-selects-21-research-proposals-to-advance-human-space-exploration

Tiger Profiles — Wayne Newhauser

The journey to produce thousands of pieces of personal protective equipment, or PPE, started in the garage of LSU Medical Physics Program Director Wayne Newhauser.

Working with Biomedical Engineering student Meagan Moore, Physics student Maxwell Cole, LSU alumnus Cathlin Disotell, and in partnership with the Bella Bowman Foundation, Newhauser began developing prototypes for gowns and other PPE as shortages of the important gear made headlines across the nation. The university's COVID-19 response team assessed the gown design and determined it could be scaled. Under the directive of Interim President Tom Galligan, the work moved from Newhauser's garage to the Pete Maravich Assembly Center, where a cross-campus team of experts came together to make operation "Protect the Protectors" a reality.

Dr. Wayne Newhauser

Why did you feel called to help?

It just felt like the logical thing to do. My background is physics and engineering. We are, by and large, problem solvers that like to help others by providing solutions, usually through science and technology. In fact, medical physics, this is what we do normally, but of course in other areas of medicine.

How did you use your expertise and knowledge to respond to the COVID-19 crisis?

At the outset, and even now, I would be reluctant to claim having much technical expertise in this area. Having built many devices and instruments in my career, experimental skills were helpful. More importantly, scientists are generalists, and we know how to apply general scientific methods to any problem. We are mentally accustomed to having to repeat the cycle of try, fail, refine many times to solve hard problems. And we routinely build and dissolve collaborative teams to tackle our bigger problems. These non-technical skills were important.

How has the pandemic affected you personally and professionally?

On a personal level, it was really heartwarming and gratifying to witness the small army of volunteers that actually did the early work, then later to see "Big LSU" dedicate staff and other resources to scale things up. Throughout the entire response, everyone's goodwill was evident, and we never had even a single argument. Professionally, I met many colleagues at LSU across the campus and in our community that I otherwise probably would never have encountered. The COVID response did consume about 18 hours a day for two months, so I did get a bit behind in reading my email, but other than that it was entirely a positive experience.

What are the lessons learned that you think we will take from this experience?

Several things. First, when we, collectively, are motivated to act with urgency, there is little we cannot accomplish, even if we have to improvise and pivot at times. Second, disasters remind us that Louisiana has a very strong sense of community. Third, I was somewhat shocked to see just how nimble and quick LSU can be when it is unleashed. I hope the community appreciates the exemplary leadership of LSU, state and federal government, industry partners, and our not-for-profit service organizations, such the Bella Bowman Foundation, who all helped with our response. These organizations collaborated harmoniously to get the job done quickly. In summary, having seen the potential of our state in response to this crisis, I believe we should set our sights much higher, and perhaps in some different directions, once this crisis has fully passed.

What makes LSU unique in this situation to respond?

LSU has an amazing array of resources to mobilize and bring to bear on virtually any problem, big or small, acute or chronic. Individually, the faculty, students, and staff are incredible resources. When assembled in teams, they are truly fierce.

Where is Cancer Research Headed Next?

Research behind cancer treatments are not just about the development of a cure but about the person in need of the cure.

From College of Science website on March, 2021

Since physical distancing was implemented to slow the spread of COVID-19, the importance of being connected has never been more apparent. And connecting with friends, peers, and colleagues via social and digital networks has required using the most expansive artificial network: the world wide web.

This "information superhighway" carries ideas, art, science, and commerce to every corner of the world and to different platforms, and to emphasize the importance of this, we often use language, like "information is the life blood of the digital economy."

The word "blood" underscores how vitally important it is. In fact, it is hard to overstate the important role of blood flow in human health. It carries oxygen and nutrients, disease and drugs, hormones, and immune cells. Blood leaks, such as trauma and strokes, can be fatal, as are some blockages in arteries. A wide spectrum of research aims to enable better treatments.

In some of his latest research, Dr. Wayne Newhauser, the LSU Department of Physics & Astronomy's Dr. Charles M. Smith Chair in Medical Physics, along with LSU doctoral alumnus Will Donahue are the first to fully detail blood flow through any single organ or tissue through computational modeling.

"Blood flow—it's fundamental to everything, to normal physiology, performance modulation, drug delivery, radiation side effects. We use blood in figurative language a lot. 'Students are the lifeblood of a place,' or 'My house is a cash hemorrhage.' Blood is clearly at the center of life. It carries oxygen, carries nutrients, carries drugs. If there's a disruption, it can cause a fatal stroke, heart attack, or embolism," Newhauser said.

"(Prior to this work,) no one had simulated the basic physics of blood flow through an entire human organ, if you can believe that. What people have done is model blood flow in complete detail in one cubic millimeter of an organ, and they've modeled blood flow throughout the entire body but with absolutely no detail of the smaller vessels."

Featured Stories

The human body contains approximately 20 billion individual blood vessels that deliver nutrients and oxygen to tissues. While blood flow is a well-developed field of research, no previous studies have calculated the blood flow rates through more than 5 million connected vessels.

Setting out to prove that this was computationally possible—with the assistance of LSU's Center for Computation and Technologies—, the researchers designed and implemented a two-step computational algorithm to calculate the blood flow rates using principles of steady-state fluid dynamics, an accurate approximation for the microvascular and venous structures in the human body.

They were able to demonstrate that it is computationally feasible to calculate the blood flow rate through 17 billion vessels in 6.5 hours using 256 compute nodes.

"It was hard, but that's the beautiful thing about the era that we're in…what's really hard today, the computing technology is going to turn that into duck soup tomorrow, so we were the first to get there," Newhauser said.

But what are the larger implications of this development?

What often happens is medical treatments can assist in curing a patient of their ailments, but sometimes those same treatments can create other potentially long-lasting—terminal, in some cases—issues. For example, radiation therapy thins tumor blood vessels, reducing the amount of oxygen and nutrients delivered and effectively causing the tumor to starve. However, approximately five to 25 percent of patients are affected with radiation necrosis, a possibly fatal side-effect linked with radiation-induced vascular injury.

This newly developed computational modeling of blood flow rate in entire organisms may assist in research on drug delivery, treatments of cancer metastases, and changes of physiological performance. With the example of radiation, physicians could more confidently focus on sterilizing tumors, while simultaneously sparing surrounding healthy tissues, which will lead to longer survival and better quality of life.

For Newhauser, finding methods that limit collateral health damage to patients post-medical treatments has been a driving force in his scientific career.

"We're always trying to be aggressive in terms of treating the cancer but being conservative and gentle on the patient, so they don't have a lot of serious consequences from the treatment.

"Everybody loves talking about the war on cancer, but few are keen to talk about the collateral damage from friendly fire, so most of my career has been devoted to trying to reduce the harmful effects in healthy tissues."

This specific project organically grew from a family loss-turned-life-changing-endeavor. On New Year's Day in 2011, Trey and Kim Bowman, of the Bella Bowman Foundation in Baton Rouge, were told their seven-year-old daughter, Bella, had been diagnosed with an ependymoma brain tumor.

Featured Stories

A successful surgery succeeded the discovery of the tumor, and Bella moved forward with her treatment. However, eight months after receiving proton radiation treatment, Bella developed what is known as brain stem radiation necrosis, a rare side effect from the radiation she had received.

Though there are no known treatments for radiation necrosis, the Bowmans opted to begin hyperbaric oxygen treatment, a type of treatment used to speed up healing in tissues starved for oxygen. After more than 60 rounds, Bella showed signs of regression rather than improvement.

Bella Bowman - photo credit: Trey Bowman

"She started showing signs of breathing issues, so we made the decision to put her on a tube. (After the tube was eventually removed), she lived for 10 days. She couldn't walk or talk, but she was completely aware," said Trey Bowman.

"Those last 10 days, they were probably the most heroic days of her life because she taught so many people so much. She began to teach us in those moments, rather than us teaching her. Those were powerful days for her." Bella passed away on December 23, 2011.

It was the outcry and support from the community following Bella's passing that catapulted the Bowmans' decision to start a foundation in their daughter's name. When a team was formed, the foundation's board decided it wanted to focus on three components: 1) to fund research, 2) to provide continuing education around pediatric brain cancer, and 3) to supply comfort care to the children and families faced with similar circumstances.

"With the research, we wanted to explore what the sensitive topic to us was, which was radiation necrosis. First, it was like, what even is this? What's being done about it? The treatment plans these kids get…is it because of their age, weight? What goes into the treatment planning process?

"And I wanted to find someone who was as passionate about this and who wanted to draw more visibility to this research, and I had a eureka moment." Drawn to an article that popped up in his email, Trey Bowman read the subject line that included, "proton radiation" and "Wayne Newhauser."

"Turns out the person I was searching for was two exits down the interstate from my house," he said.

Following an impactful conversation, the Bowman Foundation formulated some ideas with Newhauser, and a collaboration was born. The foundation has since supplied Newhauser and his students with funding needed not only to complete this specific research project, but other projects that have created foundations for future researchers to thrive and solve similar problems.

"We accept the fact that it takes a lot of research to be impactful and to change medicine," Bowman said. "We know we aren't going to immediately be able to make change, so what's been rewarding is being able to see how our sponsorship or our participation has not just been to write a check. It's truly been able to have an impact not only in science, but personally for students to define and crystallize their career paths. We will never be able to see that with our own child.

"And we've always said if we can be impactful to change the outcome of one child's treatment plan or radiation therapy, we say mission accomplished."

Bowman and Newhauser are planning the next phase of their research collaboration, which involves raising funds and establishing new collaborations with other leading research groups. They aim to launch the next phase in the Fall of 2021.

Featured Stories

Going the Distance: Innovation in Radiation Research Takes LSU Medical Physics Student from Mary Bird Perkins Cancer Center to SpaceX

Students and graduates of the LSU medical and health physics program are changing oncology, space travel, and more.

Elsa Hahne, LSU Office of Research & Economic Development on April 5, 2021

Medical and health physics is a specialized field where the laws of physics are applied to medicine and human health. A bit obvious from the name, perhaps, but the applications are wide-ranging. While cancer treatment and space travel would appear to be quite distant from each other, radiation can be the deciding factor between life and death in both areas. It can be used for treatment or diagnosis through medical imaging (X-ray, CT, MRI, ultrasound) as something desirable and useful, but it can also be a threat to people and equipment traveling to the International Space Station, Moon, and Mars, since continuous background radiation in space, beyond the Earth's protective magnetic field, is one of the hard limits to how much time anyone and anything can spend out there.

Nousha Afshari and Jared Taylor at SpaceX

The data scientists use to measure radiation and its effects on people is not always accurate. This is partly because "life in space" is a new thing, and also because we cannot—not ethically and on purpose—expose humans of all different shapes and sizes to radiation, just to see what will happen to them. Much of the research must be done in theory.

"I was thinking of working in a cancer clinic until I joined Dr. Chancellor's research group and the SpaRTAN Lab at the beginning of last semester, but our program offers a lot of options," said Jared Taylor, in his third year of the LSU medical physics doctoral program. "Now, I can't wait to help solve some of the biggest challenges for commercial spaceflight."

NASA adheres to the recommendation that astronauts should be grounded if their total exposure to radiation, which builds up over time, gives them a 1-in-30 chance of dying from it. But the data scientists use to measure radiation and its effects on people is not always accurate. This is partly because "life in space" is a new thing, and also because we cannot—not ethically and on purpose—expose humans of all different shapes and sizes to radiation, just to see what will happen to them. Much of the research must be done in theory, while some of the data we have on radiation and related health outcomes in practice (such as after the nuclear disasters in Fukushima in 2011 or Chernobyl in 1986), doesn't translate well; it's usually from high exposures during a short time instead of low exposures over a longer time.

To get more accurate data, Taylor along with other students in the SpaRTAN (Space Radiation Transport & Applied Nuclear Physics) Lab are developing new models and ground-based space radiation analogs (meaning, environments here on Earth that replicate the complex situation in space—in theory, and in a lab)

together with their advisor, Jeffrey Chancellor, assistant professor in the LSU Department of Physics & Astronomy.

One of the students in their research group is Megan Chesal, who is a LaSpace graduate fellow working toward a master's degree in medical physics with plans for a Ph.D. where her continued research as part of the SpaRTAN group will dive into artificial intelligence and machine learning. Originally from Natchitoches, Louisiana, she is helping the group develop intricate, quite beautiful, and fully digital 3D visualizations of human bodies, called computational phantoms. They can be used to study and predict the biological effects of various types of radiation (different particles and energies) on specific organs, for example. By creating a computerized anatomical man (CAM) and a computerized anatomical female (CAF), Chesal is helping her team see differences in outcomes between men and women. While she got her bachelor's degree in physics at LSU, her work is now merging with art and biology.
"Our projects influence each other quite a lot," Chesal said. "Jared is taking my work in new directions while giving me new ideas for mine. It's a fun feedback loop."

Chancellor and Taylor are currently in the process of filing a patent on technology that uses artificial intelligence to design custom radiation shielding for spacecraft.
The ultimate goal of the group's research, of course, is to enable future long-duration spaceflight—perhaps even space colonization. (Chancellor is working on a separate research project with Paul South, assistant professor of plant physiology in the LSU Department of Biological Sciences with a joint position in the LSU AgCenter, on seedlings in space; how we potentially could grow food on spaceships and on the Moon and Mars for future generations.) Chancellor and the SpaRTAN Lab also has three current grants from NASA, totaling over $2.5 million, and two additional grants from LaSpace. (Chancellor has previously provided the go or no-go recommendation for NASA space missions.)

Chancellor and Taylor are currently in the process of filing a patent on technology that uses artificial intelligence to design custom radiation shielding for spacecraft. Their overarching goal, in line with their larger research group, is to develop multiple shielding profiles to help save lives in the design of new space vehicles, but also evaluate the shielding used today on the International Space Station, SpaceX Dragon, and more.

"Given that you only have a certain amount of weight you can bring up there, better shielding is very much an optimization problem," Taylor said.

Recent advances in 3D-printing technology offer promising new solutions as well.

"It's about where to put the shielding and how much of it to put where; location and thickness, but also the material itself," Chancellor explained. "We can now print multiple materials over one solid object in

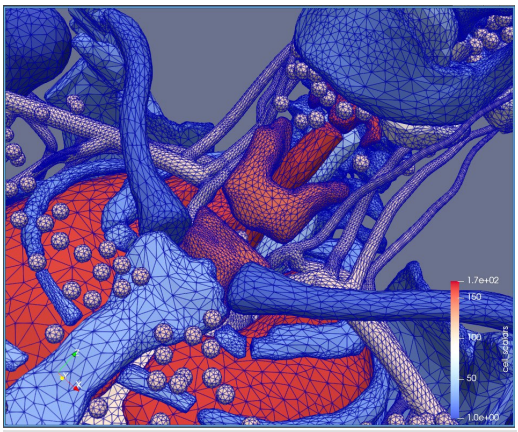
layers. It all depends on where you need the most protection and the least protection. There are instances where you want the radiation to go through because it's moving fast enough—by adding shielding and slowing it down, you could actually increase your exposure. So, instead of having three or four inches of shielding all over, we've developed a way to optimize it for the topography of a particular vehicle."
SpaceX was the first private company to send astronauts into orbit last year. Visiting the facility in Hawthorne, California last December, Taylor presented his team's research. With him was also Nousha Afshari, a fellow student in her first year in the medical physics program, intent on a future career in cancer treatment and research. She became all the more motivated to engage in reserach while working as part of a team that primarily treated cancer patients at the Voice Center in Baton Rouge, housed in the same building as Mary Bird Perkins Cancer Center, before joining LSU.

"I was constantly seeing nearly identical patients who had the same background, lifestyle, cancer in the same location, and the same type of radiation treatment," Afshari said. "But one would have horrible, chronic side effects while the other would be fine. That just bothered me. Why don't we know more? Why can't we give patients better statistics on how the radiation is going to affect them? That's kind of the driving force behind the research I want to do at LSU. I came into this program with the goal of helping as many people as possible."

Afshari's Ph.D. work will build upon some of the findings and outcomes of Taylor's and Chesal's projects in producing new ways to predict and understand radiation-induced damage. This will have implications for both space exploration and clinical radiotherapy.

LSU and Mary Bird Perkins Cancer Center, a community-owned and not-for-profit care facility, have collaborated closely for decades

LSU and Mary Bird Perkins Cancer Center, a community-owned and not-for-profit care facility, have collaborated closely for decades. The medical physics program at LSU functions as a research arm and on-demand resource to help find answers and solutions to questions and needs that arise in the clinic, while students get hands-on training and occasionally employment at Mary Bird Perkins after they graduate. The clinic's newest staff member, Christopher Schneider, grew up in Ponchatoula, Louisiana and graduated with a Ph.D. in medical physics from LSU in 2019. He has not yet completed his two-year clinical residency at Mary Bird Perkins, but already accepted an offer for a permanent position.



Master's student Megan Chesal is helping Chancellor's group develop intricate, quite beautiful, and fully digital 3D visualizations of human bodies, called computational phantoms. They can be used to study and predict the biological effects of various types of radiation (different particles and

"We need both scientists and clinicians to help alleviate the burden of cancer; both globally and especially here in Louisiana," Schneider said. "As a lifelong Louisianan, having a world-class program such as LSU's right in my backyard has meant everything to me; I found my calling in the medical physics program, and that will allow me to stay here and give back to this state and community that have given me so much."

The head of the Mary Bird Perkins team, Chief Operating Officer and Chief of Physics Jonas Fontenot, is also an LSU graduate—he added an MBA to his resume last year.

"The LSU-Mary Bird Perkins partnership has become best practice for public-private partnerships with the impact it imparts on student learning and patient care," Fontenot said. "There are few programs with such robust academic and clinical components to provide the highest level of education to those studying medical physics. Research opportunities with LSU bring a strength to our radiation oncology services that is unmatched in the nation."

"Meanwhile, the demand for high-quality graduates in this field is intensifying," he continued. "Many physicists are nearing retirement age, and the general population is getting older and living longer, which means we see more cancer cases. Almost 28,000 people are expected to be diagnosed with cancer in Louisiana this year, and that number is estimated to increase. This is why it's important that LSU continues to grow and expand its program to provide fully-prepared medical physicists who are ready to serve patients as key members of the oncology team."

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Director of the LSU medical and health physics program, Wayne Newhauser, is proud of its unbeatable job placement rate for graduates, 100%. As president of the national Society of Academic Medical Physics Program Directors, he has a fairly broad perspective.

"We're very student-focused and students are part of all of the research we do," Newhauser said. "Students are expected to write up their research and submit to journals and even our master's students usually have at least one published paper before they leave. Our graduates are highly sought-after, and although it might not be obvious to the average person why space research is lumped in with medical research, we all have to learn the same theories and techniques."

Collaboration is Newhauser share two patents; their team member Associate Professor Joyoni Dey was just awarded a new patent on technology to improve breast cancer imaging together with several colleagues in the LSU chemistry department and elsewhere on campus; and they're continuously recruiting new talent.

Meagan Moore (on left) 3D-printed a full-size human phantom for radiation therapy research, called "Marie" (because of radiation researcher Marie Curie and also because her head comes off like Marie Antoinette). Marie is the purple lady on the right, and other than helping with research in labs and clinic, she's been on display in art galleries. Moore says

"I love engaging with things that are still unknown."—*Meagan Moore, LSU biomedical engineering student and close collaborator on several projects with the LSU medical and health physics program*

Meagan Moore, a current LSU biomedical engineering student and full-time manager of the Andrea Clesi McMakin '74 STEM Lab at St. Joseph's Academy (an all-girls Catholic school in Baton Rouge) is considering a Ph.D. in medical physics. She's been working with Newhauser on several projects already, including 3D-printing a full-size human phantom for radiation therapy research, called "Marie" (because of radiation researcher Marie Curie and also because her head comes off like Marie Antoinette). Moore won 1st place at LSU Discover Day for her poster on Marie and enjoys working in what she calls "the maker space" where art meets science.

More recently, Moore was an integral part of LSU's PPE production effort for COVID-19, which started in Newhauser's garage and grew to fill the Pete Maravich Assembly Center, or PMAC. She's now teaching herself machine learning and is involved in two medical physics projects at LSU; one for the Centers for Disease Control and Prevention (CDC) on better fitting face masks (12 different designs are tested on 5 different face shapes and sizes, each 3D-printed, to see which masks contain more of the breath; a collaboration with the LSU textile department), and one to prevent bruxism, grinding of the teeth. Some of her work is also used in one of Chancellor's NASA-funded projects.

"I love mashing different technologies together, and medical physics allows me to be extremely innovative with things people don't necessarily understand," Moore said. "I love engaging with things that are still unknown."

For Taylor and Afshari, going to SpaceX to present their research also meant venturing into the unknown.

"Presenting at SpaceX was an opportunity to initiate future collaboration with the company; a chance to present the projects our group is pursuing that would benefit their space exploration efforts," Afshari said. "We were understandably nervous to present, but the experience resulted in a positive first meeting."

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Taylor agreed:

"It was more of a conversation; they had questions for us and we had questions for them, and they also gave us a tour of the whole facility. We saw the first capsule, the Starlink satellites, and then as we were talking and walking around, we see them building an engine and the people working on it stopped to look up at us. It was a great experience."

Podcast: A Glowing Interview with Space Radiation Expert Dr. Jeff Chancellor, Part 1, Part 2, Part 3 (Space 3D Podcast)

LSU physics graduate students invited to present space radiation research at SpaceX (*Reveille*)

Phantom Project: Moore 3D Prints First Full 'Human' for Radiation Therapy Research (LSU College of Engineering)

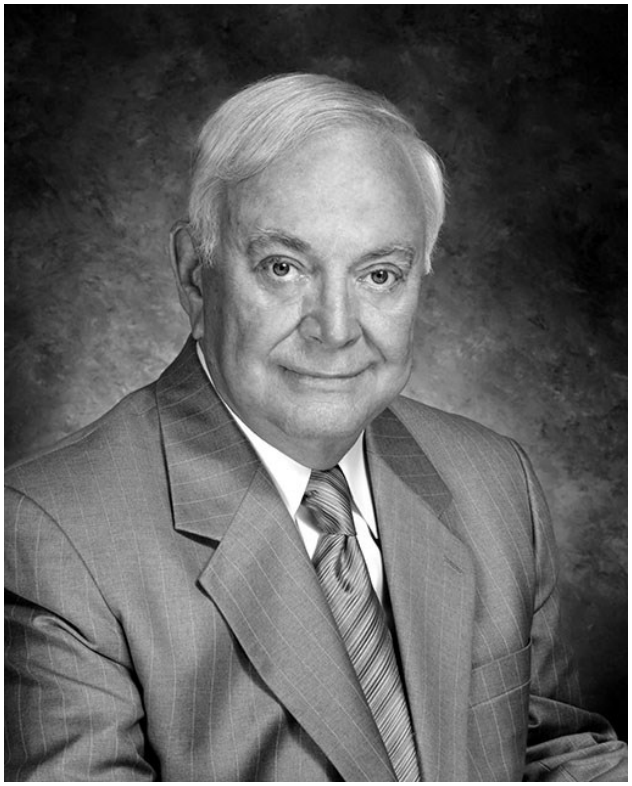
Where is Cancer Research Headed Next? (LSU College of Science)

Featured Stories

LSU College of Science Mourns the Death of Distinguished Alumnus and Noted Physician Dr. Charles M. Smith

LSU biological science alumnus and physician Dr. Charles M. Smith died quietly in his sleep on September 15 at 2:22 a.m.

Dr. Smith blazed many trails and wore many hats throughout his life some of which included veteran, physician, cancer survivor, public servant, philanthropist, and friend. He is one of Louisiana's own, a Bogalusa native that established roots in Calcasieu Parish with a successful medical career spanning more than six decades.



Dr. Charles Smith

Dr. Smith was a charter member of the LSU College of Science Dean's Circle. He was also a member of the LSU Foundation's Laureate Society and the Forever LSU Society (formerly named the 1860 Society). He was a 2009 Hall of Distinction honoree and was inducted into LSU's Alumni Hall of Distinction in 2017.

Dr. Smith earned a bachelor's degree in biological sciences from LSU in 1951 and a medical degree from LSU Medical School New Orleans in 1955. He practiced medicine in Sulphur, Louisiana, for 35 years and served as Calcasieu Parish coroner for more than 20 years.

He also served in the U.S. Air Force from 1955 to 1957 as a flight surgeon in Europe before opening his family medical practice, which he later expanded to include industrial medicine and chemical dependency.

In retirement, Dr. Smith underwent cancer treatment that saved his life and in response established the Dr. Charles M. Smith Chair of Medical Physics in the Department of Physics and Astronomy. The $1 million chair, created in partnership with Mary Bird Perkins Cancer Center and matching funds from the Louisiana Board of Regents Support Fund, played a major role in the program achieving accreditation from the Commission on Accreditation of Medical Physics Educational Programs Inc.

Following the creation of the chair, the program became one of only 11 accredited graduate medical physics programs of its kind and resulted in the creation of a state-of-the-art facility that benefits the community, the state, and the region through cancer research initiatives.

Smith is known as a 'quiet philanthropist,' one who impacts individuals and organizations through acts of kindness and generosity without recognition. His philanthropic spirit is evidenced by his numerous volunteer commitments over the years.

"Our college has greatly benefited from Charles' expertise, generosity, and friendship," said Cynthia Peterson, dean, LSU College of Science." We will miss him, and we are forever impacted by his infectious zeal for his university, community, and commitment to paying it forward."

Podcast: A Glowing Interview with Space Radiation Expert Dr. Jeff Chancellor

From *Space 3D Podcast* , *Hosted by Emily Carney, Tom Hill and Eleanor O'Rangers*

Part 1, Part 2, and Part 3

Co-hosts Tom Hill and Eleanor O'Rangers continue their interview with physicist and space radiation expert Jeff Chancellor in this podcast episode.

Jeff is an Assistant Professor of Physics at Louisiana State University with research interests in applications of how heavy ion radiation interacts with soft and condensed matter for ground-based analogs, manned spaceflight vehicle structure, shielding, and clinical healthcare.

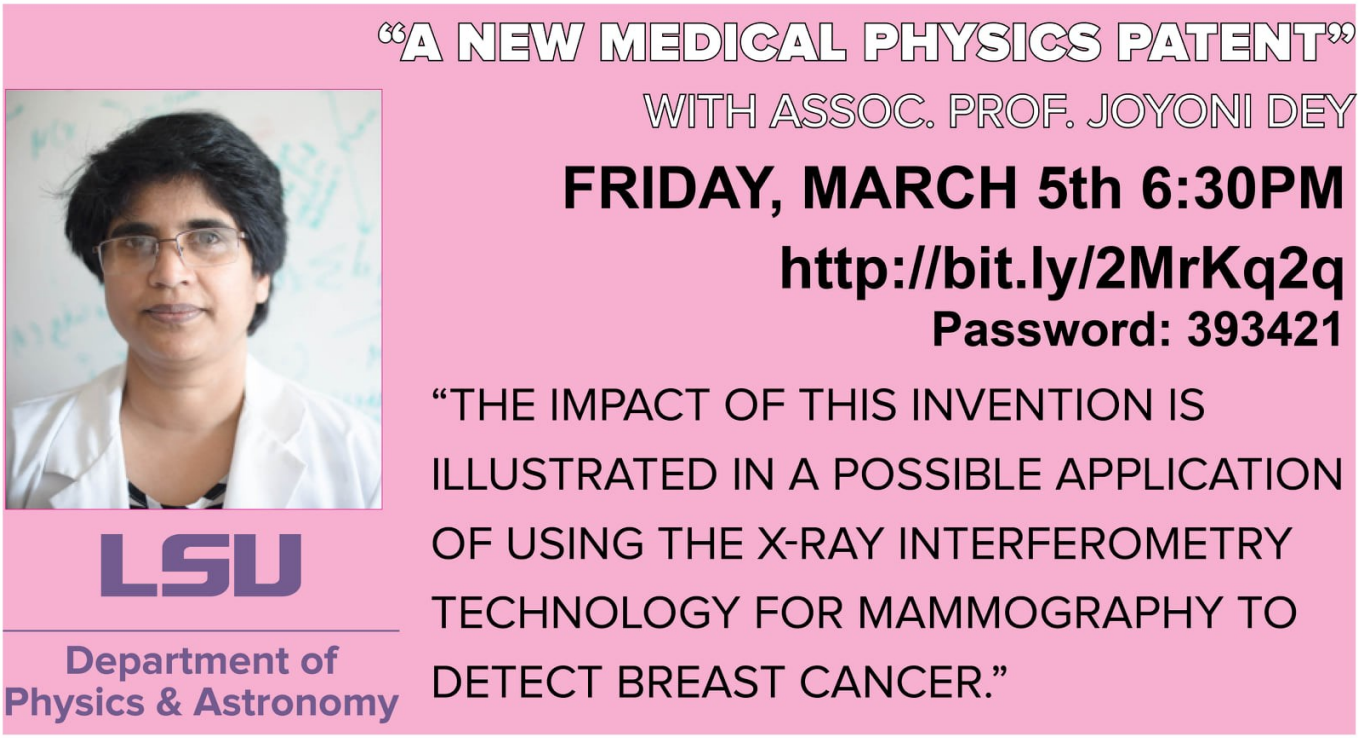
During part 2 of our interview, we'll discuss the specific risks posed by space radiation to space explorers, starting with defining the types of radiation that concern us in space exploration. We'll delve into the particulars of risks specific to the lunar and Martian surface and conclude with beginning to explore issues pertaining to radiation shielding, which can be summed up simply as: easier said than done.

Part 3 of our interview starts with a discussion of options for radiation shielding of astronauts during interplanetary travel and while on the surface of either the moon or Mars. We'll discuss how certain radiation risks may vary according to the solar cycle--- and then we'll transition to radiation event risk prediction…. Which at best, is an evolving and still somewhat unpredictable discipline. We'll learn about how NASA's tolerance for radiation risk is evolving, particularly in relation to short-term risks to crew, and we'll conclude with a few more provocative questions for Jeff. If you are interested in reading the open-access review on space radiation that he and his colleagues have just published, check out the April 27, 2021 issue of Journal of Environmental Science and Health Part C, pages 113-128 for the article entitled, "Everything you wanted to know about space radiation but were afraid to ask."

Medical & Health Physics Program in the News

LSU Professor receives US Patent for Breast Cancer detection invention

Check our associate professor Dr. Joyoni Dey's talk about her medical physics patent here: https://youtu.be/nBxS-0RUaiA



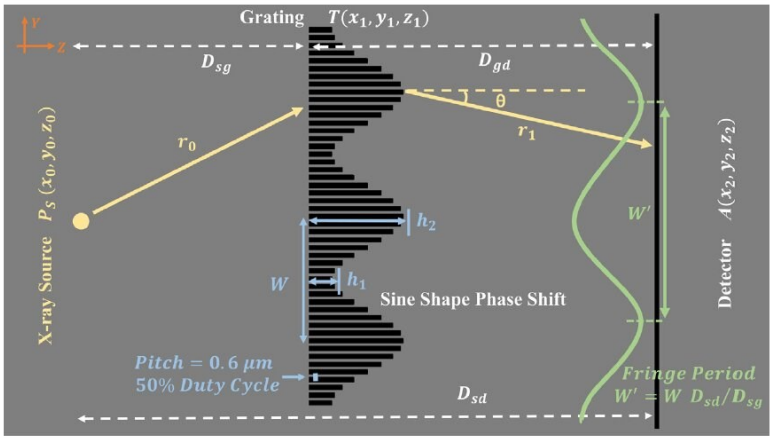
Joyoni Dey Awarded U.S. Patent to Improve Detection of Breast Cancer

LSU Physics & Astronomy , Science X

By Mimi LaValle on January 11th, 2021

Associate Professor Joyoni Dey, together with colleagues in the J. Bennett Johnston, Sr. Center for Advanced Microstructures and Devices (CAMD), Department of Chemistry and Department of Physics & Astronomy, has received a U.S. Patent to be issued on Dec 22, 2020. "Phase-Contrast X-Ray Interferometry," U.S. Patent No. 10872708, features Dey as the primary inventor of modulated phase gratings to produce visible X-ray interference fringes in clinical detectors without requiring an expensive fluence-absorbing analyzer.

"The impact of this invention is illustrated in a possible application of using the X-ray interferometry technology for mammography to detect breast cancer," Dey said. "Using the modulated phase grating, clinicians won't need the expensive absorbing analyzer typically required for X-ray interferometers. This way, the amount of radiation, or dose, can be lowered to that equivalent of conventional mammography. Note that phase-contrast X-ray provides phase as well as small-angle scatter information, which sets it apart from conventional X-ray attenuation images. These multiple modalities obtained with the same dose in a single scan will provide tremendous clinical benefits and are expected to improve specificity and sensitivity of pathology detection."



Modulated Phase Grating (black, left) creating visible patterns on detector (yellow,right). The diagram is not to scale. Credit: Xu, Ham, Dey, JMI, 7(2), 2020

Dey and Ph.D. graduate Jingzhu Xu investigated the concept in simulations. Dey, her graduate students and co-investigator Dr. Kyungmin Ham are further pursuing the idea in the context of breast cancer mammography with support from the National Institutes of Health (NIH, NIBIB program) Trail-blazer R21 grant "Breast Cancer Detection and Imaging using Analyzer-less X-ray Interferometry," which Dey was awarded in July 2020.

"Phase-Contrast X-Ray Interferometry," U.S. Patent No. 10872708, J. Dey, N. Bhusal, J.P. Dowling, K. Ham, V. Singh, December 22, 2020

LSU Medical Physicist Receives Prestigious Shalek Award

Mimi LaValle

The Southwest Regional Chapter of the American Association of Physicists in Medicine has announced LSU Associate Professor Kenneth "Kip" Matthews as the 2020 recipient of the prestigious Robert J. Shalek Award.

Matthews' nominators Andrew Morrow and Joe Dugas cited in their nomination "in recognition of his service to SWAAPM, most recently as Treasurer; his contributions to education through his dedication to the LSU Medical Physics Program and his work with the summer REU program that has been crucial to providing an introduction for students to the nature of research-oriented careers in physics and astronomy, fostering the development of research-related skills and knowledge; and for serving as a mentor to many students and physicists in the Southwest Chapter, including our present officers."

Matthews earned a BA degree in 1990, majoring in chemistry and physics, from Austin College, in Sherman, TX, and his PhD in medical physics from The University of Chicago. From 1997 through July 2001, he served as a clinical and research physicist at Rush-Presbyterian-St. Luke's Medical Center in Chicago. Matthews received his clinical certification in medical nuclear physics from the American Board of Radiology in June 2001, and joined the faculty of the Department of Physics & Astronomy at LSU in August 2001. He currently serves as deputy director for the LSU Medical and Health Physics program, and holds adjunct appointments in Radiology at the LSU Health Sciences Center in New Orleans, in Comparative Biomedical Sciences at the LSU School of Veterinary Medicine, and at Pennington Biomedical Research Center. In 2017, Matthews was named a Fellow of the American Association of Physicists in Medicine.

His research interests span nuclear medical physics and diagnostic imaging physics. A primary interest is developing detector systems for radioisotope imaging, which uses the gamma-ray emissions of internally-distributed radiopharmaceuticals to visualize in vivo physiology, pathophysiology and metabolic processes. A second interest is the translation of x-ray interferometry imaging technology into a clinical diagnostic imaging tool. Matthews collaborates on imaging-related projects with LSU faculty in chemistry, biology, engineering, veterinary medicine, and other areas. Because of LSU's extensive involvement with radiation therapy physics, he is also interested in the application of medical imaging techniques within radiation therapy.

Medical & Health Physics Program in the News

Previously, LSU Professor Emeritus Kenneth Hogstrom received the Shalek award in 1990. "Dr. Matthews well deserves the recognition, and I know that Dr. Shalek would be pleased with what he has accomplished in teaching and helping guide young people into our field, " said Hogstrom. "I also think it special to have been nominated by two of our former LSU students/trainees."

The Robert J. Shalek Award is presented annually to a Full or Associate Member of the Southwest Chapter of the American Association of Physicists in Medicine in recognition of exemplary service to, or representation of, the chapter. The Shalek Award may also be given to a SWAAPM member who has recently achieved landmark contributions to the field of Medical Physics; these contributions may be publications, technical innovations, professional service, public lectureships, or other achievements.

The purpose and jurisdiction of the SWAAPM chapter is to encourage interest in the field of physics in medicine and biology and to promote and improve the profession of medical physics within the Southwest areas, and to encourage interest and training in medical physics and related fields. It is organized exclusively for charitable, scientific, and educational purposes.

LSU Associate Professor Kenneth "Kip" Matthews as the 2020 recipient of the prestigious Robert J. Shalek Award.

LSU Goes to the Moon

Elsa Hahne, LSU Office of Research & Economic Development
May 4, 2021

As the U.S. lands on the Moon next year, for the first time since 1972 and the Apollo program, LSU technology built by students in close collaboration with industry partners will report back from the lunar surface. Undergraduate students in five different LSU colleges and schools are leading the mission, which will make future space travel safer for astronauts and equipment. Meet the team behind Tiger Eye 1.

Students lead the charge. Haley Pellegrin (LSU College of Science), Katie Hostetler (LSU School of Art + Design, LSU College of Humanities & Social Sciences), and Jacob Miller (LSU College of Engineering, LSU Honors College) are helping to lay the foundation for humans to return to the Moon as early as 2024.
— Photo by Eddy Perez/LSU

Next year, Louisiana State University (LSU) will be the first university in the world to put technology on the Moon. The Tiger Eye 1 research mission is part of a multi-disciplinary university-industry collaboration to make future space travel safer for people and equipment by providing insight into the complex radiation environment in space. LSU's radiation detection device is now officially on the manifest for the broader IM-1 mission, the first in a series of commercial flights (and the first-ever to land on the Moon) that will bring science and technology to the lunar surface through NASA's Commercial Lunar Payload Services (CLPS) initiative. This will also be the first time the U.S. lands on the Moon since 1972 and the Apollo program.

Students in five different LSU colleges and schools are leading the charge under the direction of Assistant Professor Jeffery Chancellor in the LSU Department of Physics & Astronomy, head of its Space Radiation Transport & Applied Nuclear (SpaRTAN) lab. All are undergraduate seniors from Louisiana:

Haley Pellegrin, from Bourg in Terrebonne Parish, is a LaSpace Undergraduate Research Fellow and member of the SpaRTAN lab where she develops new technologies to make better radiation shielding (LSU College of Science). Jacob Miller, from Crowley in Acadia Parish, is an electrical engineering major who builds new devices for medical applications (LSU College of Engineering, LSU Honors College). Katie Hostetler, from Zachary in East Baton Rouge Parish, is a graphic designer who creates art for LSU Athletics and this spring came up with the winning design for the Tiger Eye 1 mission patch; she's double-majoring in religious studies (LSU School of Art + Design, LSU College of Humanities & Social Sciences).

"It's been incredible to see and support all of LSU coming together to move this mission forward."—*Samuel J. Bentley, vice president of research and economic development at LSU*

"We're immensely proud of the LSU students leading this work on the frontier of science, technology, art, and the human imagination," said Samuel J. Bentley, vice president of research and economic development. "It's been incredible to see and support all of LSU coming together to move this mission forward. There should be no barriers to expertise, and this university-industry collaboration is a great example of how the caliber of our students and researchers can advance projects of critical importance to our nation."

Medical & Health Physics Program in the News

"This student-led, cross-campus collaboration reinforces LSU's impact on space exploration and planetary science," added Cynthia Peterson, dean of the LSU College of Science. "As we prepare to put people on the Moon again in 2024, we must not only understand what it takes to protect our astronauts, but also what is required to perform science experiments in a space environment and safeguard the technologies needed to conduct the research."

Test flight. LSU Assistant Professor Jeffery Chancellor, faculty lead for the Tiger Eye 1 mission, holds six NASA grants (including two from LaSpace and two from the Translational Research Institute for Space Health, or TRISH, both NASA-funded) and has previously provided the go/no-go recommendation for NASA space missions. By being on the approved sender list, he was able to email Hostetler's LSU Tiger Eye 1 mission logo design up to the International Space Station and astronaut Shannon Walker who took a picture of it on her iPad last month, mounted in the clear glass cupola with Earth in the background. Click to see a larger image

—Photo by U.S. Astronaut Shannon Walker

Through its medical and health physics program and the SpaRTAN lab, LSU helps agencies and companies understand background radiation in space, one of the hard limits on how much time people and equipment can spend out there, beyond the Earth's protective magnetic field. Understanding the types and amounts of radiation that exist on the Moon will be key to establishing a sustainable human presence on Earth's nearest neighbor as well as traveling to Mars. The data brought back by Tiger Eye 1 will further the SpaRTAN lab's research on improved radiation shielding in both materials and design.

"We have models and predictions for human health risk on the Moon, but we don't yet have actual measurements of the radiation spectrum on the lunar surface," Chancellor said.

"Now that we'll get real data, we can use it to validate our models, make better predictions, and increase the safety of future space travel."

"The radiation data we'll get on IM-1 will change the equation of what's possible in space."—*Jack "2fish" Fischer, astronaut and vice president of strategic programs at Intuitive Machines, on partnering with LSU*

The IM in IM-1 stands for Intuitive Machines, a Houston-based company pioneering humanity's next step—returning the U.S. to the surface of the Moon. IM holds NASA and commercial payload contracts for two separate lunar landings (IM-1 in the first quarter of 2022 and IM-2 in the fourth quarter) to help pave the way for the Artemis program, which will put the first woman and the first person of color on the Moon as early as 2024. The CLPS flights are all uncrewed and will make use of rovers and robots to conduct science experiments and test technologies in different areas on the lunar surface. Intuitive Machines is providing the vehicle, communication network, and mission operations center for LSU's device to safely land on the Moon and effectively conduct research. IM's Nova-C lunar lander will be launched from a SpaceX Falcon 9 rocket. The solar battery-driven vehicle will spend two weeks on the surface before succumbing to lunar night, not far from Tranquility Base where Neil Armstrong and Buzz Aldrin first walked on the Moon in July 1969 during the Apollo 11 mission.

"The two main barriers for human spaceflight are propulsion—how to get there faster—and how to protect humans and equipment from radiation," said retired Colonel Jack "2fish" Fischer, astronaut and vice president of strategic programs at Intuitive Machines. "Without the shielding and radiation modeling LSU is helping to develop, the radiation effects on crews and equipment during deep space exploration would be catastrophic."

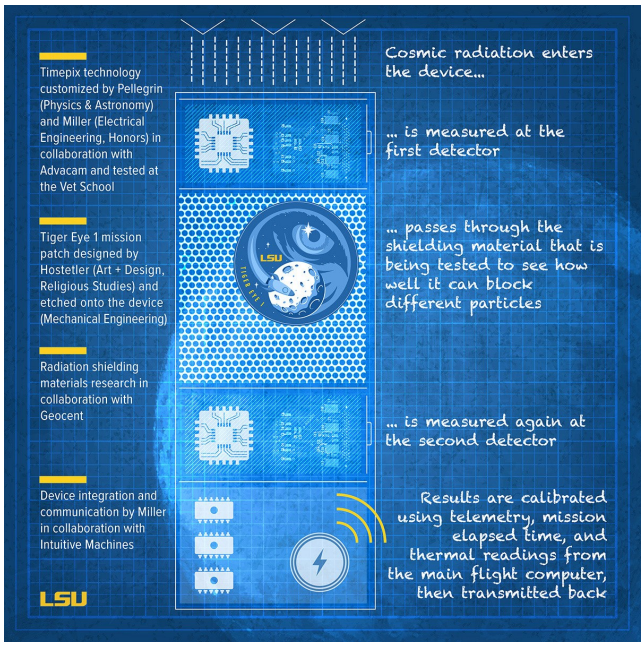
Medical & Health Physics Program in the News

"Geocent's technical strength is in its people, and we can't imagine a better way to build talent than challenging students to work together and rise to the occasion to put Tiger Eye 1 and their footprint on the Moon."—*Robert A. "Bobby" Savoie, Geocent CEO*

LSU's Tiger Eye 1 mission was enabled in partnership with Geocent, a New Orleans-based company that provides solutions and talent for the space, defense, and homeland security communities. Geocent chose LSU as a research and development partner to test some of their radiation shielding, which led to an opportunity to share physical space onboard IM-1.

"Geocent and our teammates—Plasma Processes, the University of Alabama at Birmingham, and the University of Tennessee, Knoxville—are proud to bring Geocent's ACCRES Radiation Shielding technology to the partnership with LSU and Dr. Jeff Chancellor, Intuitive Machines, and especially LSU students to work on critical research and technologies that truly advance human spaceflight and exploration," said Robert A. "Bobby" Savoie, CEO of Geocent and LSU Engineering alumni. "We're a national company but Louisiana-born, and it's thrilling to see students from several disciplines coming together to make significant contributions to an important mission. Geocent's technical strength is in its people, and we can't imagine a better way to build talent than challenging students to work together and rise to the occasion to put Tiger Eye 1 and their footprint on the Moon."

The LSU radiation detection device is currently being customized by Pellegrin and Miller who, as official project manager, also will engage LSU mechanical engineering's advanced manufacturing and machining capabilities to etch Hostetler's Tiger Eye 1 mission patch onto the physical device casing, which will occupy a space about the size of an iPhone 12.



Device design. One reason for the "Tiger Eye" name: the detectors in the device are configured like a telescope. The radiation enters the aperture, is measured at the first detector, then travels through the material being tested and is measured again at the second detector. This allows the researchers to understand how effective the material is for shielding the cosmic ray environment. Click to see a larger image

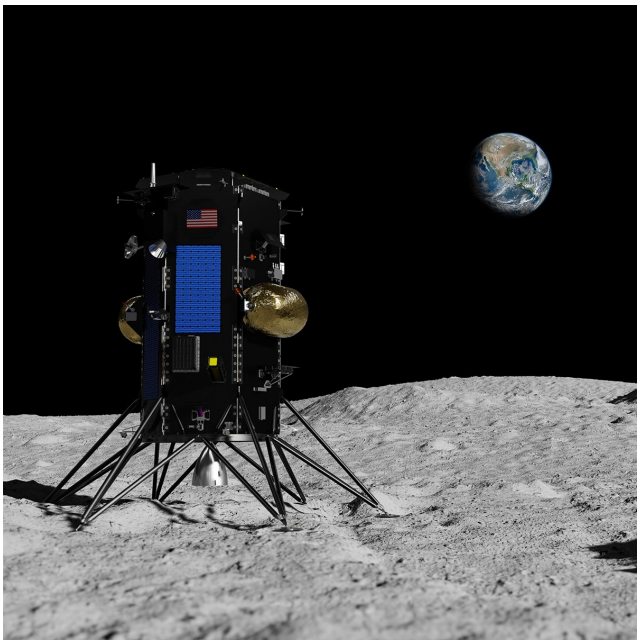
———Illustration by Elsa Hahne/LSU

"The most challenging thing on missions like these is working within strict limitations on mass, volume, power, bandwidth, and time, as well as communicating with and controlling devices from Earth, which means solving problems no one's solved before," Pellegrin said. "I'm super excited to be part of this mission and the knowledge and skills I've gained have already kickstarted my career. They helped me land an internship at Geocent, which is a dream come true since I want to work in space and missile systems development."

Pellegrin and Miller are also working with Advacam, a company based in the Czech Republic, on adapting radiation detection hardware (similar to a USB flash drive) that it has previously supplied for the International Space Station (ISS). But while you can bring laptops and off-the-shelf equipment to ISS to help integrate and connect such devices, that isn't possible on IM-1. Much of Miller's work on Tiger Eye 1 lies in software development and coding (and possibly some wiring and soldering) to make sure the data from the sensor "makes sense" to the device, which must be able to communicate with the main Intuitive Machines flight computer to receive time stamps, temperature readings, and other critical data. The LSU team is setting up a

Medical & Health Physics Program in the News

"As an engineering student, I like the challenge of doing something that's really, truly new in just a few months. It's as scary as it's appealing, and the result is going to benefit human spaceflight for years to come."—*Jacob Miller, electrical engineering senior and Tiger Eye 1 project manager*



The vehicle. The phone-sized LSU radiation detection device will be mounted on the outside of Intuitive Machines' Nova-C lunar lander with no mass between itself and the surrounding environment after the lander disconnects from the SpaceX Falcon 9 launch rocket.

————-Photo montage by Intuitive Machines

Earlier this year, Pellegin walked the Timepix chip the team will be using as a sensor over to the LSU School of Veterinary Medicine's linear accelerator (where radiation is used to help treat animals with cancer) for initial testing.

"Most of our patients are dogs and cats, but we do treat the occasional reptile, rabbit, horse, or other pet," said Jayme Looper, director of the LSU Small Animal Hospital and its radiation oncology services. "Our recent collaboration with the LSU medical physics team to test the radiation detection device prior to its journey to the Moon is an example of a long history of intercollegiate collaboration at LSU."

Chancellor did the initial characterization of the Timepix technology in the 1990s as a master's student under advisor Larry Pinsky at the University of Houston, who did the dosimetry for the Apollo mission.

"It takes a lot of time to sort of gather all of the information about how everything communicates and the protocols everybody's following," Miller added. "It gets complicated really fast. But as an engineering student, I like the challenge of doing something that's really, truly new in just a few months. It's as scary as it's appealing, and the result is going to benefit human spaceflight for years to come."

For Hostetler, the design of the mission patch didn't feel as new as it felt familiar. In a recent LSU Art + Design profile, she shared how her first opportunity to send art into space actually arrived already in fifth grade.

"It was a contest to design a flag to go into space and I was really far ahead in the contest but ended up in second place," Hostetler remembers. "So, when my professor, Courtney Barr, came to me with the Tiger Eye 1 opportunity, I was like, 'Fifth-grade me would be proud.' My mom was especially excited."

Barr recruited seven undergraduate and graduate art students to come up with 19 different design ideas for the space patch. After careful vetting and input from the other students on his team, Chancellor chose one of Hostetler's designs, which features a fierce but protective tiger eye overlooking a spacecraft landing on the Moon—because he appreciated the symbolism, and also because "it looked awesome."

"The patch is an important symbol because it includes everyone on the team," Chancellor said. "Folks like Danielle Cintron, Darya Courville, Greg Trahan, Shemeka Law, and countless others at LSU have worked really hard behind the scenes to make Tiger Eye 1 possible. Space missions do not happen entirely in a vacuum, and the patch itself helps to represent that idea."

Medical & Health Physics Program in the News

"We're especially excited about the tremendous opportunity Tiger Eye 1 is for LSU students to be involved in forefront space-science research."—*Jeffrey Blackmon, chair of the LSU Department of Physics & Astronomy*

With an eye on IM-2, Chancellor expects to call on Hostetler and the LSU Art + Design team again soon. Intuitive Machines will bring an ice drill and use a small drone ship to explore hard-to-reach areas on the Moon and test the Nokia 4G LTE network, while LSU is considering sending up a larger and more robust radiation detector, based on lessons to be learned on IM-1. When it comes to shielding materials and design, the vast spectrum of radiation in space doesn't lend itself to easy or particularly intuitive solutions. You can't just add more shielding or encase everything in lead. Not only would this add too much mass and cost; shielding in the wrong place could also slow down the radiation particles to the extent they'd get "trapped" inside the space vehicle or the human body, causing devastating damage to astronauts and equipment. Sometimes minimal shielding is the safest option, and the LSU SpaRTAN lab's research will continue to help the aerospace industry find out exactly where and when and how to effectively use it.

Mission patch. LSU Art + Design senior Katie Hostetler approached the design challenge of creating an iconic patch for the LSU Tiger Eye 1 mission the way she'd previously designed logos, but with more detail. She also researched the history of space patches, which tend to be bold, literal depictions of missions, often with hidden "insider" symbolism that resonates with the core team. She explored various eye shapes before settling on the final design, configured in something close to a yin-yang pattern (balance between the eye and the moon).

——- Art by Katie Hostetler/LSU

The upcoming missions reflect the importance and impact of LSU's Space Grant status, supporting critical space research across a range of topics. LSU manages the National Center for Advanced Manufacturing (NCAM), a partnership between the university, NASA, the State of Louisiana, the University of New Orleans (UNO), and the UNO Research and Technology Foundation focused on applying advanced manufacturing technologies in support of NASA space programs. NCAM is located at NASA's Michoud Assembly Facility in New Orleans, where critical hardware components for exploration vehicles—such as core Space Launch System (SLS) rocket components for NASA's Artemis mission to the Moon—are engineered, manufactured, and tested. Beyond state-of-the-art research, NCAM has a strong educational and talent development mission, working with aerospace companies to build the next generation of scientists and engineers.

"With NASA's Johnson, Stennis, Michoud, and Marshall Space Centers all within arm's reach, LSU is helping to develop the workforce needed for the next step in space exploration—long-term, crewed space missions and a return to the lunar surface," said Jeffrey Blackmon, chair of the LSU Department of Physics & Astronomy. "The Louisiana Space Consortium (LaSPACE) and the High-Altitude Student Platform (HASP) have played major roles, but we're especially excited about the tremendous opportunity Tiger Eye 1 is for LSU students to be involved in forefront space-science research."

Medical & Health Physics Program in the News

As the Tiger Eye 1 team works to get everything ready for launch, something else just came up—the LSU SpaRTAN lab will be flying yet another radiation detector on SpaceX's Inspiration4 mission using their Falcon 9 launch vehicle and Dragon spacecraft this September, in collaboration with Pinsky. It will launch from NASA's Kennedy Space Center in Florida and be the world's first all-commercial, all-civilian mission to space. It will circle the Earth before making a soft water landing off the Florida coast. This will be another opportunity for LSU students to form a team in support of a space mission. The team will include Jared Taylor, graduate student in medical physics who will integrate the related research into his Ph.D. project, and Duncan Wilkie, undergraduate student in physics. At least one additional student will be announced soon.

Please follow @LSUResearch on Twitter, Facebook, and Instagram for updates.

Shirts, hats, etc. bearing the LSU student-designed Tiger Eye 1 mission logo are now available through the Designs on the Geaux online store. Proceeds will support future student involvement in space research.

Read more:

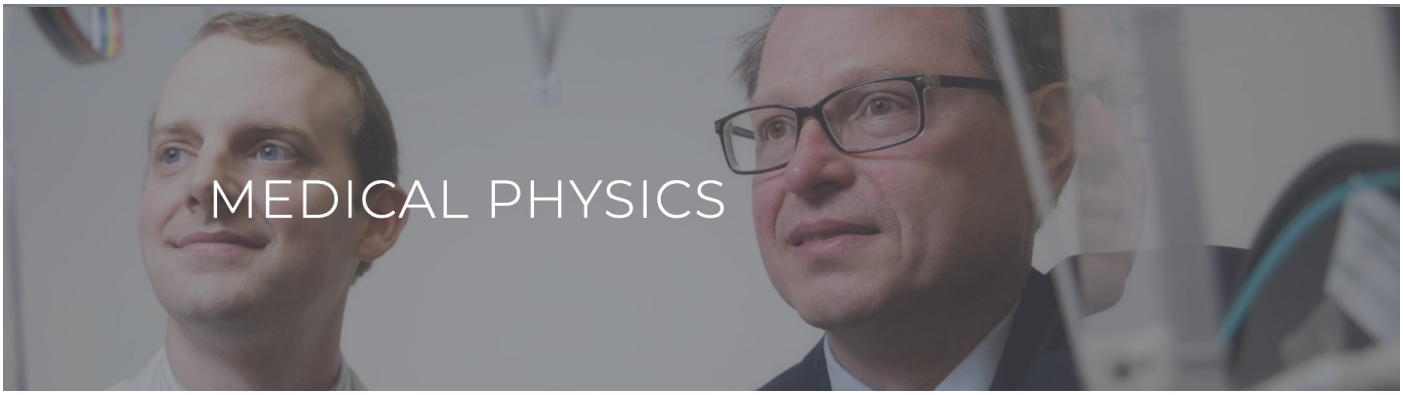
- LSU Office of Research and Foundation fundraising email - LSU Goes to the Moon
- The Advocate - This device made by LSU students will be part of NASA's 2022 moon landing — the first since 1972
- And the Valley Shook - LSU to Conquer Moon, Possibly Entire Galaxy
- Louisiana Radio Network - LSU students to send radiation detection device to the Moon
- Baton Rouge InRegister - Fly me to the moon: LSU lands on the moon with the Tiger Eye 1 radiation detection device
- Greater Baton Rouge Business Report - LSU will be first university to put technology on the moon

Medical & Health Physics Program in the News

Dr. Newhauser and his student Megan Moore discussing how they made medical gowns out of billboard material and 3D printed ventilator parts during the medical supply shortage at main library Mini Maker Faire event on Oct. 17, 2020.

Dr. Newhauser and student Megan Moore with others at Mini Maker event

CONQUERING CANCER WITH OUR TOP-RANKED MEDICAL PHYSICS PROGRAM



For Mary Bird Perkins – Our Lady of the Lake Cancer Center, striving for the highest quality patient care also means a commitment to training and developing leaders who continue pushing the boundaries of innovative medicine. The Cancer Center invests significant resources into its medical physics program; the medical specialists who help continuously challenge and improve current standards of radiation oncology.

Since 2004, the Cancer Center has collaborated with Louisiana State University (LSU) to provide the highest quality training in medical physics. These professionals apply their knowledge toward the development and use of new and current technology and ensure efficiency and safety of radiation therapy treatment plans for patients.

This partnership leverages the strengths of both organizations, bringing together the education and research resources of LSU and cancer expertise of Mary Bird Perkins to provide a direct benefit to patients receiving cancer care throughout the Gulf South and beyond.

MULTI-LAYERED HIGH-QUALITY TRAINING WITH MARY BIRD PERKINS – LSU MEDICAL PHYSICS PARTNERSHIP

The joint academic and research program between the Cancer Center and LSU is nationally recognized and accredited, consisting of a master's degree program, a doctorate degree program and the largest Medical Physics Residency Program in the United States.

The Mary Bird Perkins – LSU Medical Physics Graduate Program is nationally competitive and the only program of its kind in Louisiana to be accredited by the Commission on Accreditation for Medical Physics Educational Programs (CAMPEP). This program is also regarded within the medical physics community as being among the best in the world for training clinical medical physicists.

PATIENTS DIRECTLY BENEFIT FROM MARY BIRD PERKINS – LSU MEDICAL PHYSICS PARTNERSHIP

Medical & Health Physics Program in the News

The incredible distinctions achieved by the Mary Bird Perkins – LSU Medical Physics partnership continue to attract the brightest minds from around the world, bringing medical physics expertise to the area and helping supply Louisiana with the best professionals in this highly specialized discipline.

Here are just a few of the amazing things this partnership has done to impact patient care:

- **Lowered Risk of Side Effects –** Research for predicting long-term, treatment-related side effects led to the development of tools allowing clinicians to compare treatment options and select the one with the lowest predicted risk of side effects.
- **Increased Treatment Accuracy and Comfort –** Research helped establish best practice standards for new radiation therapy delivery technologies, translating into increased patient comfort and improved accuracy by significantly reducing time spent during treatment.
- **Lowered Risk of Organ Damage –** Research on a deep inspiration breath hold technique for radiation treatment of left-sided breast cancers is helping to reduce radiation exposure of the heart and lowering the risk of organ damage.
- **Better Cosmetic Outcomes Following Breast Cancer Surgery –** Research conducted on the Cancer Center's radiation treatment machines led to a chest wall treatment technique following breast cancer surgery that improves cosmetic outcomes.

Learn more on how Mary Bird Perkins Cancer Center conquers differently at www.marybirdlake.org/conquer.

Selected Publications

- J.P.K. Bernstein, A. De Vito, D.S. Weitzner, R. MacAulay, M. Calamia, R. Brouillette, H. Foil , O.T Carmichael, J.N. Keller, "Examining Relationships between Multiple Self-Reported Sleep Measures and Gait Domains in Cognitively Healthy Older Adults" Gerontology 2020; 66:47–54
- J. Xu, K. Ham, J. Dey, "X-ray Interferometry without Analyzer for Breast CT Application, a Simulation Study", J. of Medical Imaging, vol. 7, no. 2, 023503 (2020).
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- L. J. Wilson, W.D. Newhauser, C. W. Schneider, F. Kamp, M. Reiner, J.C. Martins, G.Landry, A. Giussani, RP. Kapsch, K. Parodi. "Method to quickly and accurately calculate absorbed dose from therapeutic and stray photon exposures throughout the entire body in individual patients". Medical Physics, 14 January 2020.
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- L. J.Wilson, & W. D. Newhauser. "Justification and optimization of planned exposures: a new framework to aggregate arbitrary detriments and benefits". Radiation and Environmental Biophysics (2020). June 18, 2020. · 59 (3), 389-405.
- M Lis, M Donetti, W Newhauser, M Durante, J Dey, "A modular dose delivery system for treating moving targets with scanned ion beams: Performance and safety characteristics, and preliminary tests "Physica Medica, European Journal of Medical Physics, Volume 76, P307-316, August 1, 2020.
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Seminars and Presentations

1. Duncan ES, Nakkawita S, Lucas H, Carmichael OT, de Queiroz M. Modulating Operator Vigilance with Transcranial Direct Current Stimulation (tDCS). 2020 OHBM Annual Meeting, June 23-July 3, 2020. Montreal, Canada.

2. Hoddy KK, Singh P, Beyl RA, Kirwan JP, Newton RL, Jr., Carmichael OT. Adequate sleep duration enhances cardiovascular benefits of physical activity intervention in older African Americans (PAACE). Poster presentation. SLEEP 2020. August 2020.

3. Singh M, Carmichael OT. The Molecular Basis for 31P MRS-Based Phosphocreatine Muscle Resynthesis Rate Measurements in Healthy Adults. Digital poster presentation. ISMRM 28th Virtual Annual Meeting & Exhibition. August 2020. *Poster won the Magna Cum Laude Merit Award.

4. October 29, 2020. "Neuroimaging-based Biomarker Development for Clinical Trials." Biomarkers for Addiction Treatment Development: fMRI Drug Cue Reactivity as an Example, 3rd ISAM Neuroscience Interest Group (ISAM-NIG) Webinar in Collaboration with ENIGMA Addiction Working Group.

5. Xie, Y., Guo, B., Zhang, R. (2020). "Cost-effectiveness Analysis of Radiotherapy Techniques for Whole Breast and Post-Mastectomy Irradiations", 62th Annual meeting of AAPM, Vancouver, Canada, Jul 12 – 16.

6. Xie, Y., Bourgeois, D., Guo, B., Zhang, R. (2020). "Advanced Radiotherapy Techniques for Left-Sided Breast Cancer Patients", 62thAnnual meeting of AAPM, Vancouver, Canada, Jul 12 – 16.

7. Zhao, X.D., Zhang, R. (2020). "Accurate tracking of position and dose during VMAT based on VMAT-CT", 62th Annual meeting of AAPM, Vancouver, Canada, Jul 12 – 16.

8. Lis M., Steinsberger T., Donetti M., Newhauser W., Wolf M., Paz A., Durante M, Graeff C., "Verification of the conformity of a motion-mitigation carbon ion delivery strategy." German Society of Medical Physics 2020, September 23 - 26, 2020. Online.

9. M. Lis, M. Donetti, W. Newhauser, C. Graeff. "Performance validation of the CNAO dose delivery system at GSI: Control system for treatment moving targets with scanned ion beams." The 59th meeting of the Particle Therapy Co-operative Group, September 13-14, 2020. Online.

10. Lis M., Donetti M., Steinsberger T., Wolf M., Paz A., Newhauser W., Durante M., Graeff C. "A clinical quality assurance concept for conformal motion-synchronized dose delivery system used for four-dimensional ion therapy." The 59th meeting of the Particle Therapy Co-operative Group, September 13-14, 2020. Online.